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Braced Rafter Barn Framing

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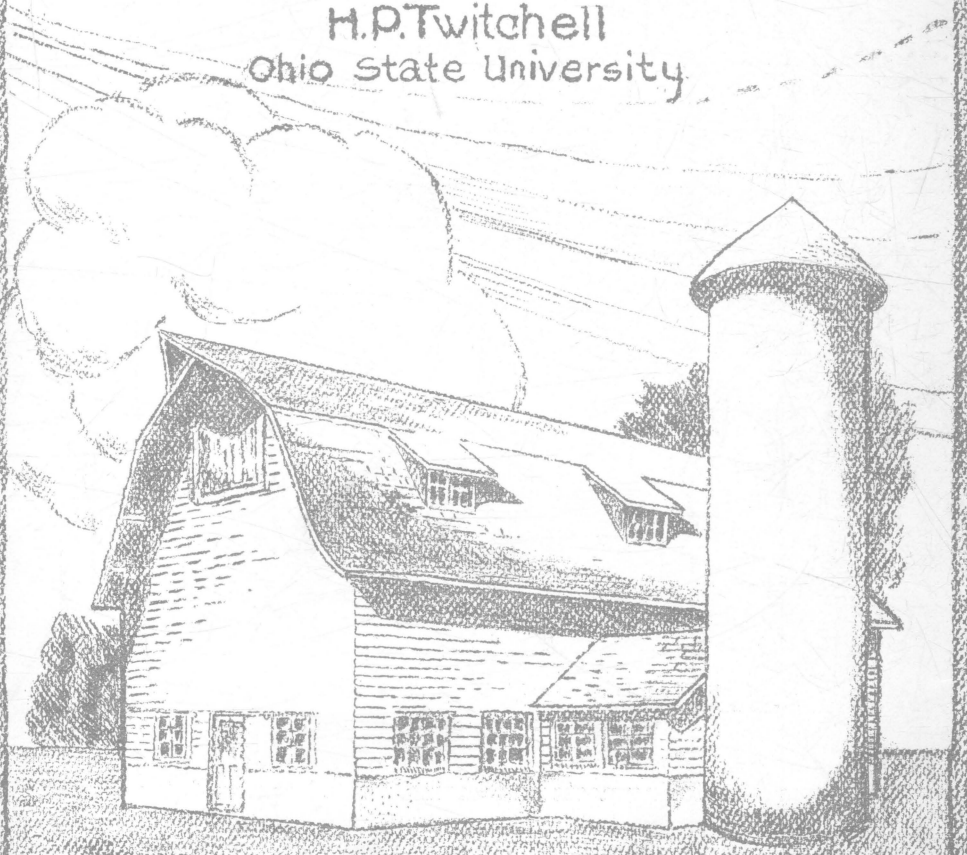

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Braced Rafter Barn Framing

By

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A good barn frame must be strong and rigid, yet should be constructed of no more lumber than is required to safely withstand the loads to which it is subjected. This economical use of lumber also implies that each piece be so placed and built into the frame that its safe strength is utilized. Modern barn haying machinery and methods of storing away hay require that the mow be

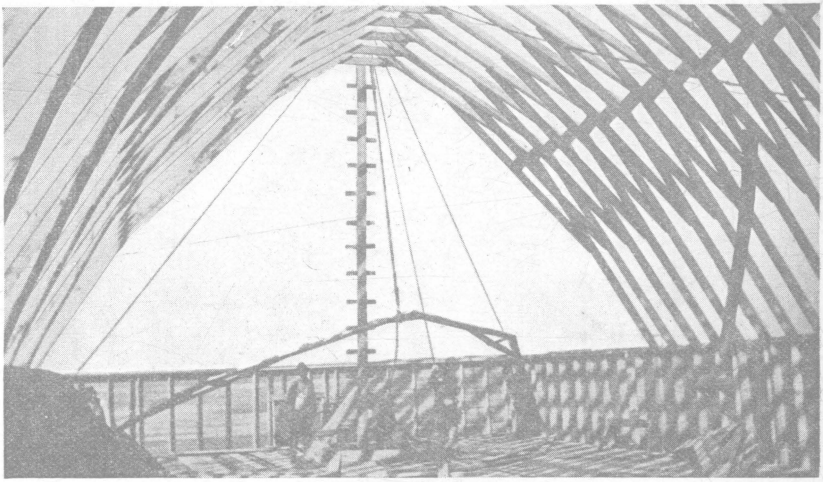

Fig. 1.—Braced rafter barn in process of building. View inside of hay mow showing method of raising trusses. Another truss ready for erection is lying on the floor. (Gin pole used in raising these trusses is shown on page 8).

free from interfering posts and beams. The barn roof, then, must necessarily be supported by trusses. These trusses should be so designed as to be easily and quickly constructed and should require only a few men to raise them. As a whole the frame should form a skeleton for a strong, pleasing, well-proportioned barn. The modern plank frame barn possesses these characteristics to a larger degree than the old timber or square frame barn.

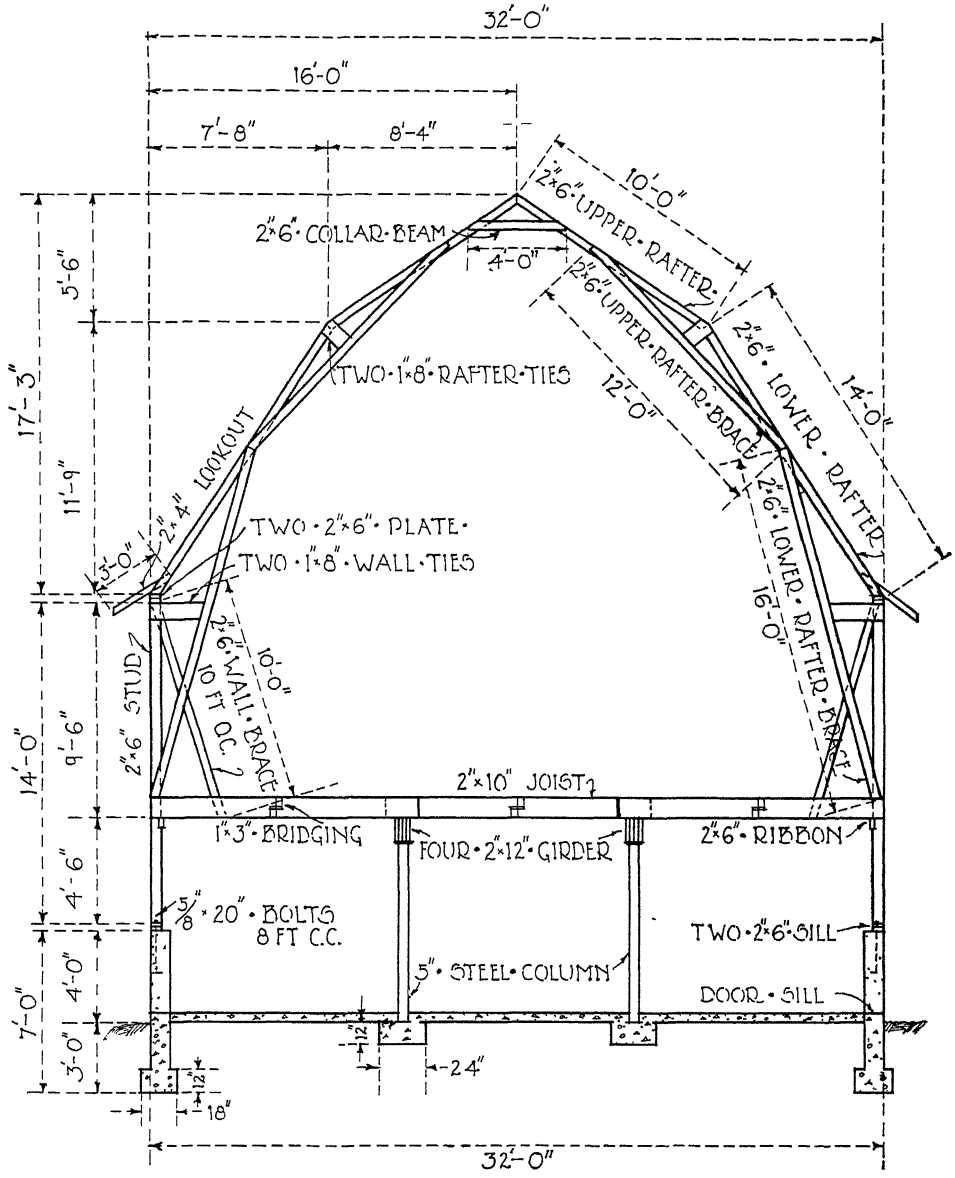

Fig. 2.—Cross section of a 32-foot braced rafter barn. Only framing details are shown. All rafters, rafter braces, ties, lookouts, studs, and joists, are spaced 24 inches on center. Wall braces are 10 feet on center. Lookouts same slope as upper rafters. (For wall and rafter tie details see Figs. 5 and 6. Girders shown in detail in Figs. 13 and 14)

Lengths of joists and spacing of columns and girders not shown. These dimensions will vary according to the floor plan. Note that spacing of girders controls width of hay door opening (see Figs. 10 and 11).

This is the narrowest width suitable for a dairy barn, altho the 34-foot width is to be preferred. A convenient general purpose barn for horses and dairy cows can be made by placing cows in two rows with horses across one end.

Framing lumber per 2 feet of length (1 bent) = 264 board feet. Loose hay capacity per 2 feet of length (1 bent) = 2.2 tons.

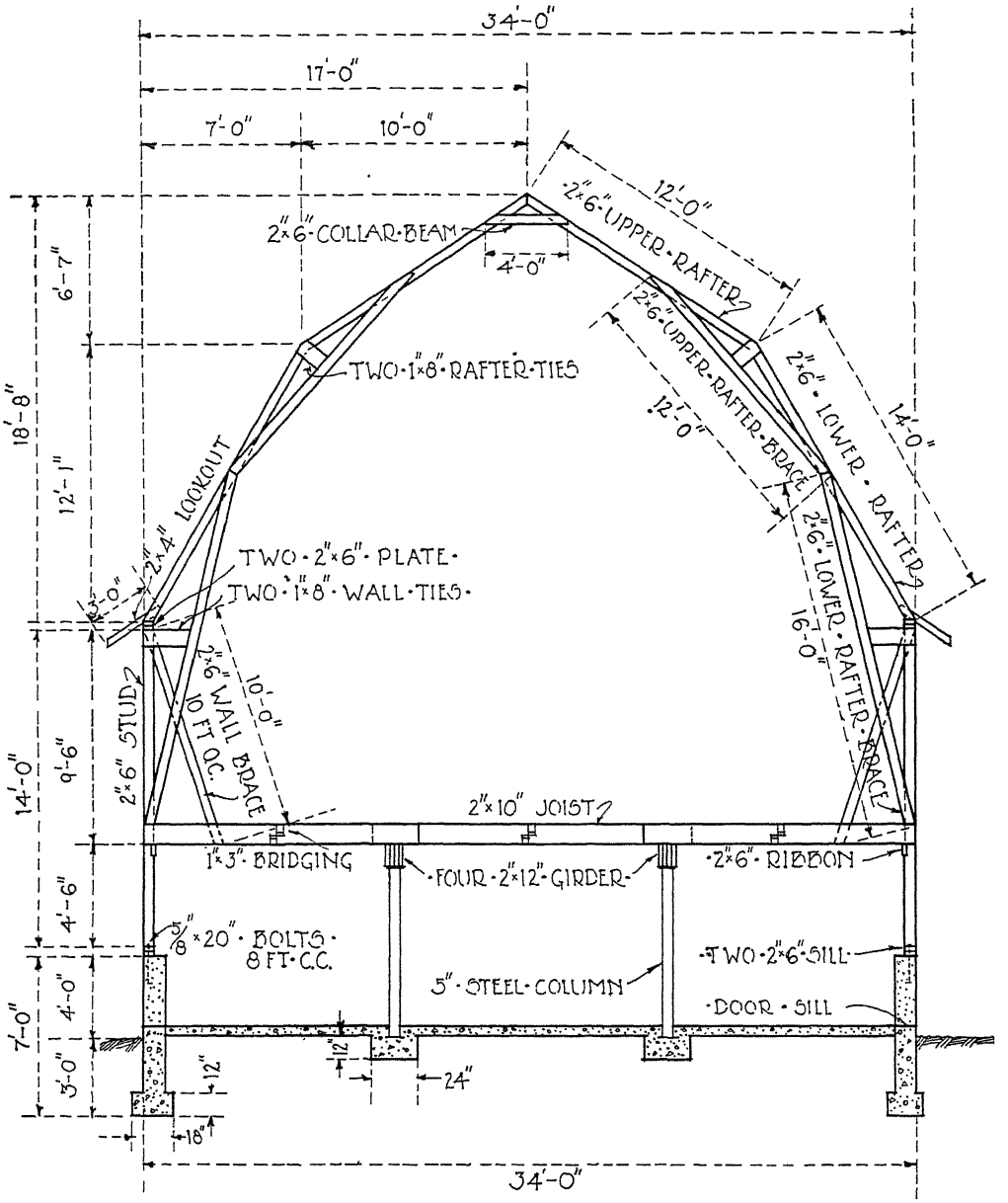

Fig. 3.—Cross section of a 34-foot braced rafter barn. Only framing details are shown. All rafters, rafter braces, ties, lookouts, studs, and joists are spaced 24 inches on center. Wall braces are 10 feet on center. Lookouts same slope as upper rafters. (For wall and rafter tie details see Figs. 5 and 6. Girders shown in detail in Figs. 13 and 14.

Lengths of joists and spacing of columns and girders not shown. These dimensions will vary according to the floor plan. Note that spacing of girders controls width of hay door opening (see Figs. 10 and 11).

This width of barn is the most practical width for dairy cattle barns (for floor plan see Fig. 21). Two rows of cows can be conveniently arranged, with three alleyways of standard dimensions. Light and ventilation is easily secured. Optimum volume of space per cow.

This width is too narrow for two rows of horses; however, it will accommodate one row of horses, with box stalls or cow pens opposite them (for floor plan of General Purpose Barn see Fig. 20).

Framing lumber per 2 feet of length (1 bent) = 271 board feet

Loose hay capacity per 2 feet of length (1 bent) = 2.4 tons.

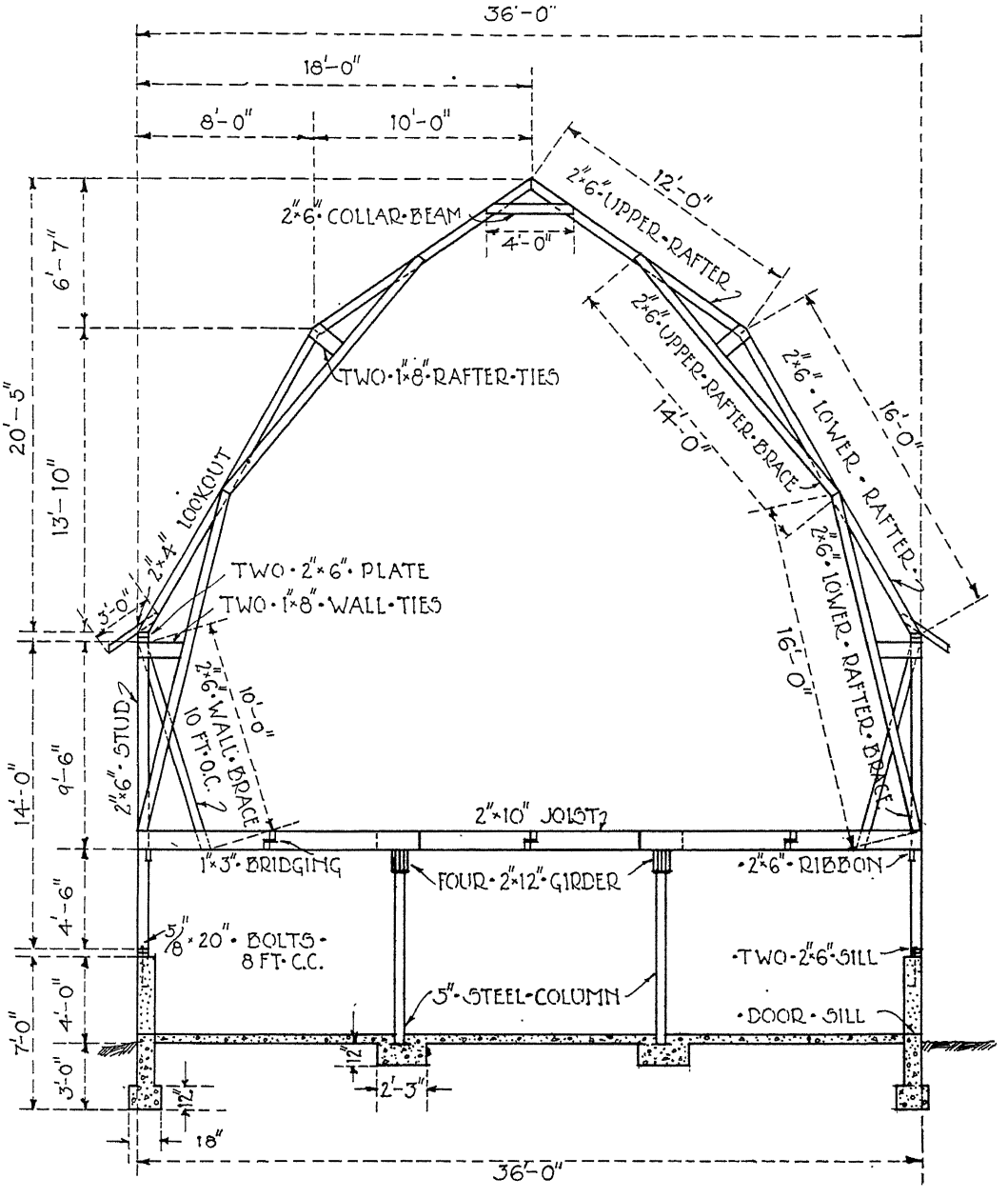

Fig. 4.—Cross section of a 36-foot braced rafter barn. Only framing details are shown. All rafters, rafter braces, ties, lookouts, studs, and joists, are spaced 24 inches on center. Wall braces are 10 feet on center. Lookouts same slope as upper rafter. (For wall and rafter tie details see Figs. 5 and 6. Girders shown in detail in Figs. 13 and 14).

Lengths of joists and spacing of columns and girders not shown. These dimensions will vary according to the floor plan. Note that spacing of girders controls width of hay door opening (see Figs. 10 and 11).

This is the most practical width for general purpose barns containing horses and dairy cows in two rows. Suitable for beef cattle barns.

Framing lumber per 2 feet of length (1 bent) = 286 board feet.

Loose hay capacity per 2 feet of length (1 bent) = 2.8 tons.

The Timber Frame Barn

The timber barn is framed of huge timbers cut and squared and set together with mortise and tenon joints, and braced in every direction at every joint. It depends for its strength upon the size of the timbers and careful work in making the joints. A big weakness lies in the fact that so much of the timbers are cut away by mortising and tenoning that the effective strength of the frame is greatly reduced. Then, too, the single wooden pin which holds the joints together makes an ineffective tie. In timber frame barns built today, these pins are often omitted from the braces with the result that they fall out when the lumber shrinks. This type of barn framing requires more lumber than the plank frame method, uses special lengths and large sizes of timber, takes from 10 to 15 men to raise the bents, and can not be built with an unobstructed mow. Its only advantage is that it can be constructed by carpenters who are unwilling to learn modern framing methods. This type of construction is rapidly being replaced by the newer and more efficient types of framing.

The Plank Frame Barn

In contrast with the old clumsy timber barns we have the modern plank frame barns. The framework of these barns is constructed entirely of 2-inch plank. The amount of time, labor, and lumber necessary to erect one of them is appreciably less than for a timber frame barn of the same size. If correctly designed and constructed they are stronger than the timber barns. There are several different types of plank frame barns, the most popular types being the braced rafter or balloon frame, the Shawver truss, and the Gothic roof. In this bulletin the braced rafter method of barn framing will be discussed.

The Braced Rafter Barn

The braced rafter type of barn construction is particularly recommended for barns not exceeding 36 feet in width, 18 feet in height from grade line to plate, and not having threshing floors. Within these limitations it has certain advantages which make it an efficient type of barn framing. The illustration on title page shows a barn of this type.

TRUSSES.—It can be seen from any one of the cross sections that the framework consists of light trusses so constructed as to form a

self-supporting gambrel roof. This type of roof provides a large, unobstructed m o w, looks better than a gable roof, and easily rids itself of heavy snow loads. The trusses are spaced 24 inches apart and are built up entirely of 2- by 6-inch pieces spiked and tied together with 1- by 8-inch boards so as to nearly form an arch. Each truss consists of two lower rafter braces, two lower rafters, two upper rafter braces, two upper rafters, and one collar beam.

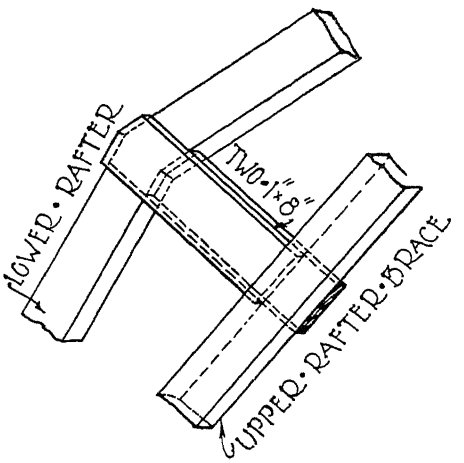

Fig 5 —Details of rafter tie

Since each truss consists of but these few pieces, there will be no heavy lifting in raising. The lower rafter brace extends from the joists to the middle of the lower rafter, where it meets the upper rafter brace. In the older braced rafter barns a space was left between the end of the two rafter braces. Recent investigations, however, have shown that this is a weak place. To eliminate this point of weakness the upper and lower rafter braces should meet as shown in the sections (Figs. 2, 3, and 4).

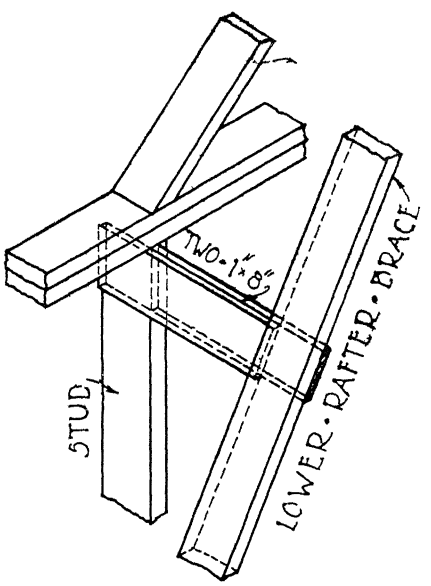

Fig. 6—Details of wall tie

The fact that the trusses are spaced only 24 inches apart means that the roof will not sag as is sometimes experienced with barns having a light roof construction supported by heavy trusses spaced 12 to 16 feet apart. With the trusses thus transferring the roof weight uniformly on all the studding, the foundation is evenly loaded. A smaller foundation can therefore be built than for a timber frame or Shawver truss barn.

The truss members are of such lengths as can be found in stock at the smallest lumber yard. This is an advantage in that it saves time in ordering special sizes.

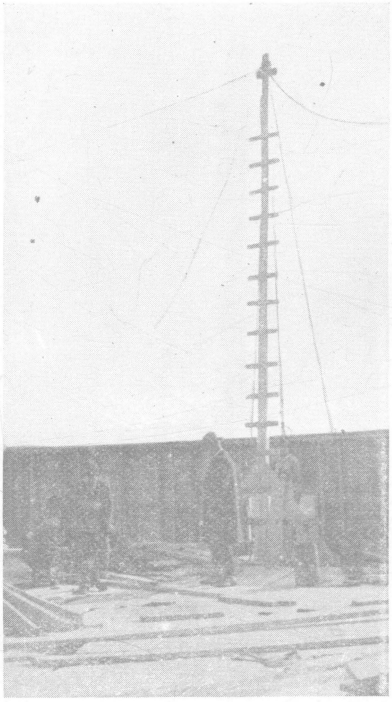

Fig. 7.—Gin pole for raising roof trusses. Note truss members being assembled on floor.

FOUNDATION AND FOOTINGS.—The foundation is usually made 10 inches thick with the inside sloping to an 8-inch width at the top. It should extend below the frost line and should rest on a footing large enough for the soil to bear up the load to which it is subjected. The footings shown in the drawings are for a firm clay soil. Door openings are not shown, as these will vary with the floor plans.

The mixture for the concrete should be 1 part cement, 2½ parts sand, and 5 parts gravel or crushed stone. Bolts, ⅝ inch by 20 inches, spaced 6 to 8 feet apart, should be placed in the concrete, heads downward, to which the sill can later be bolted.

SILLS AND PLATES.—The sill consists of two 2- by 6-inch pieces laid in a bed of mortar on the foundation. Before being placed on the

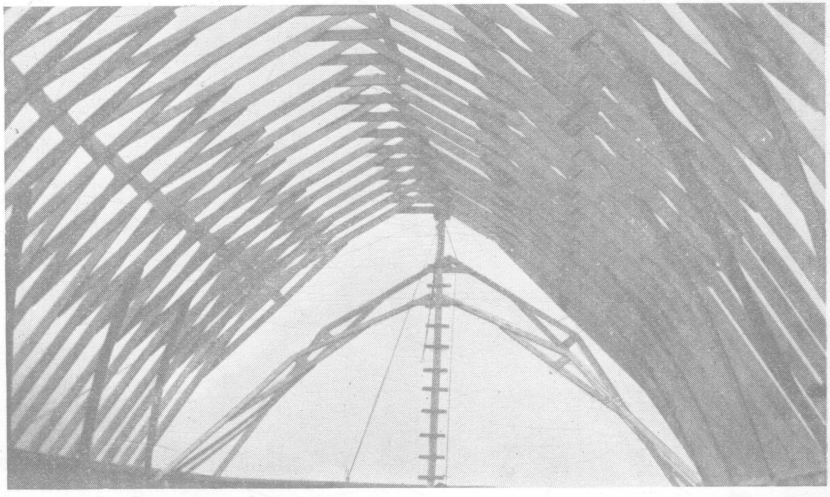

Fig. 8.—A truss being raised by the use of the gin pole and block and tackle. End truss already erected and braced.

foundation, it should be given two paint coats of a creosote compound to protect it from destruction by decay and insect attacks. When securely bolted to the foundation the farmer has good insurance against destruction of his barn by high winds. Most barns destroyed by tornadoes are lifted up or slid off their foundations and crushed. If well anchored to the foundation, danger of destruction in this manner is reduced to a minimum.

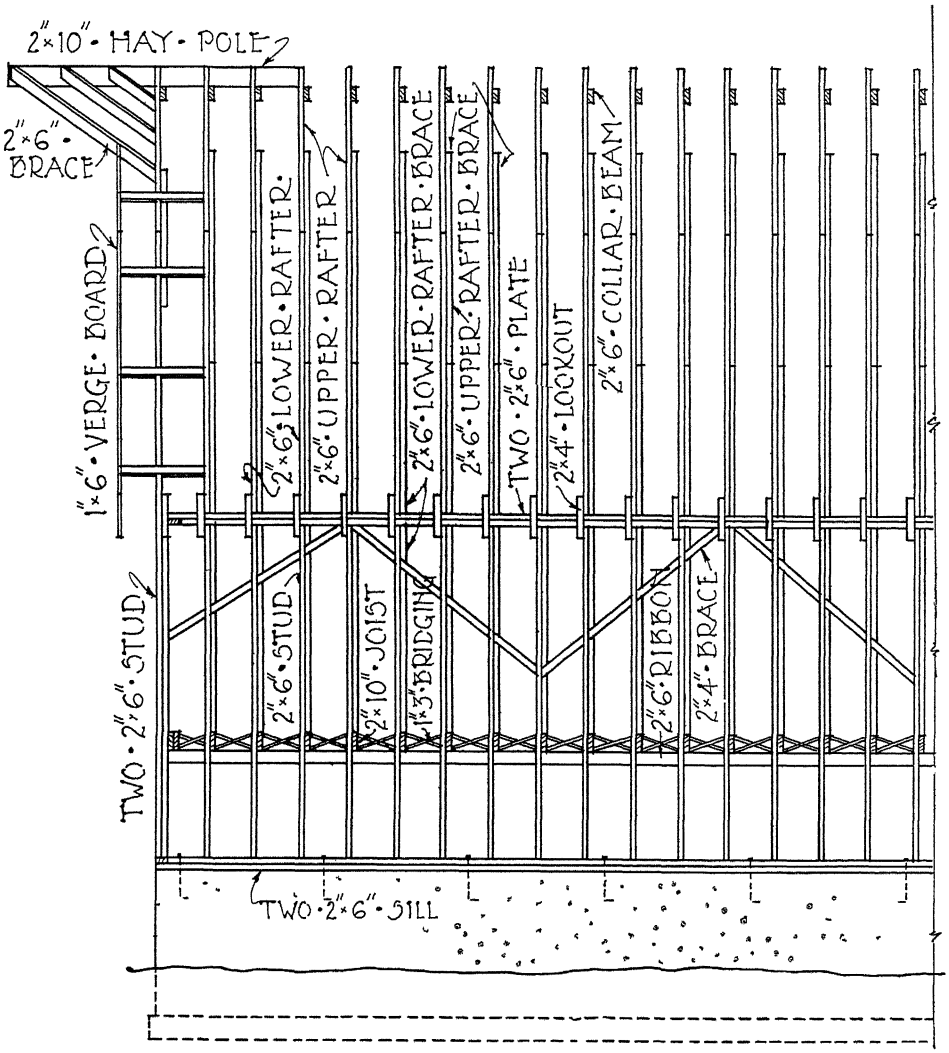

Fig 9—Side framing Door openings not shown. These will vary according to floor plans.

Figure 19 shows a barn standing in northwestern Ohio which in 1920 weathered a severe tornado. Being securely bolted, the wind could not lift it off its foundation, yet the force of the wind was so great that it did slide the entire barn and side wall foundation 4 inches toward reader. What would have happened if it had not been bolted can easily be imagined by turning to Fig. 22. It is an easy matter to pick the barn which was not bolted to the foundation. Another point brought out by this picture is that the crushed barn is an old remodeled timber barn with a new braced rafter roof. The roof has stood the test, while the timber framework of the walls has been shattered to pieces.

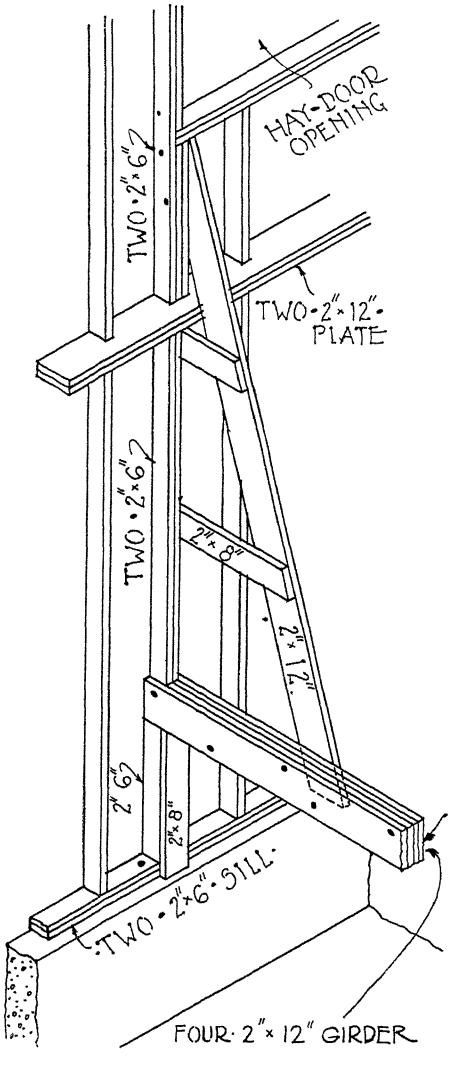

Fig. 10.—End wall brace

Note that the end wall plates are two 2- by 12-inch pieces, (Figs. 10 and 11), while the side wall plates are two 2- by 6-inch pieces. (See Sections, and Fig. 9.) The ends are the weakest parts of the barns and therefore require special construction. In addition to the larger plate, two special braces are required at each end to prevent them from bowing. These braces are shown in Fig. 10.

STUDS.—The 2- by 6-inch studs are spaced 24 inches apart on center. They are doubled at the doors, corners of the barn, and ends of the girders (see Figs. 10, 11, and 15). A 2- by 6-inch ribbon is notched into the studs to support one end of the floor joists. To prevent the side walls from spreading at the plate, 2- by 6-inch wall braces are placed 10 feet apart, as

shown in the cross sections. Wind braces, 2 by 4 inches, should be nailed diagonally to the inside of the studs.

COLUMNS.—Five-inch steel columns spaced up to 14 feet apart are to be recommended for supporting the girders. They offer less obstruction to light and ventilation than larger wooden posts, and

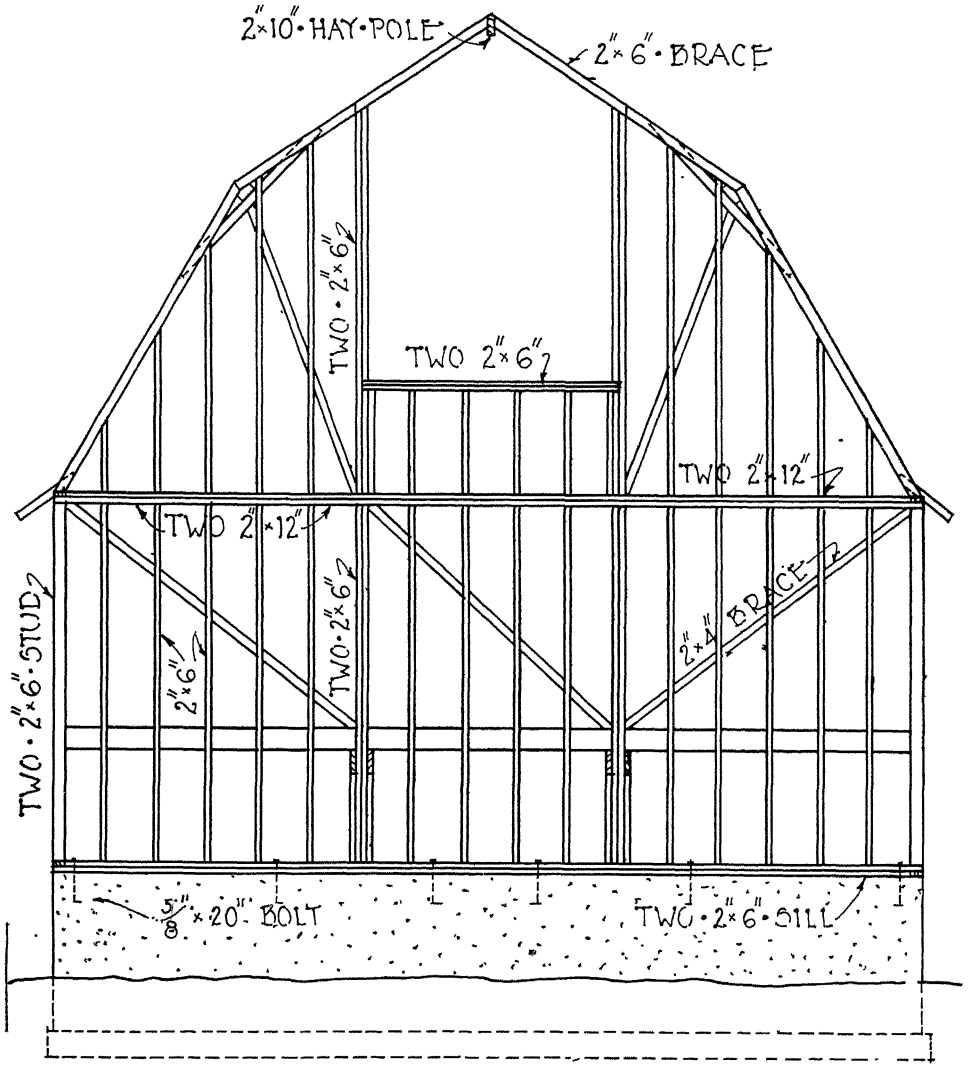

Fig 11.—End framing for a 34-foot width. Other widths similar. Note that spacing of girder controls width of hay door opening. Studs are 24 inches on center. Plate is two 2- by 12-inch pieces. For end braces see Fig. 10. The diagonal wind braces are 2- by 4-inch pieces. No door openings are shown. These will vary according to the floor plans

are sanitary and easily cleaned. Don't buy steel columns filled with concrete. The additional freight charge will more than pay for filling them on the job.

GIRDERS.—The built-up girder as shown in Fig. 13 is constructed of four 2- by 12-inch pieces bolted together with 5/8-inch bolts at intervals of 2 feet. By breaking the joints the girder is not

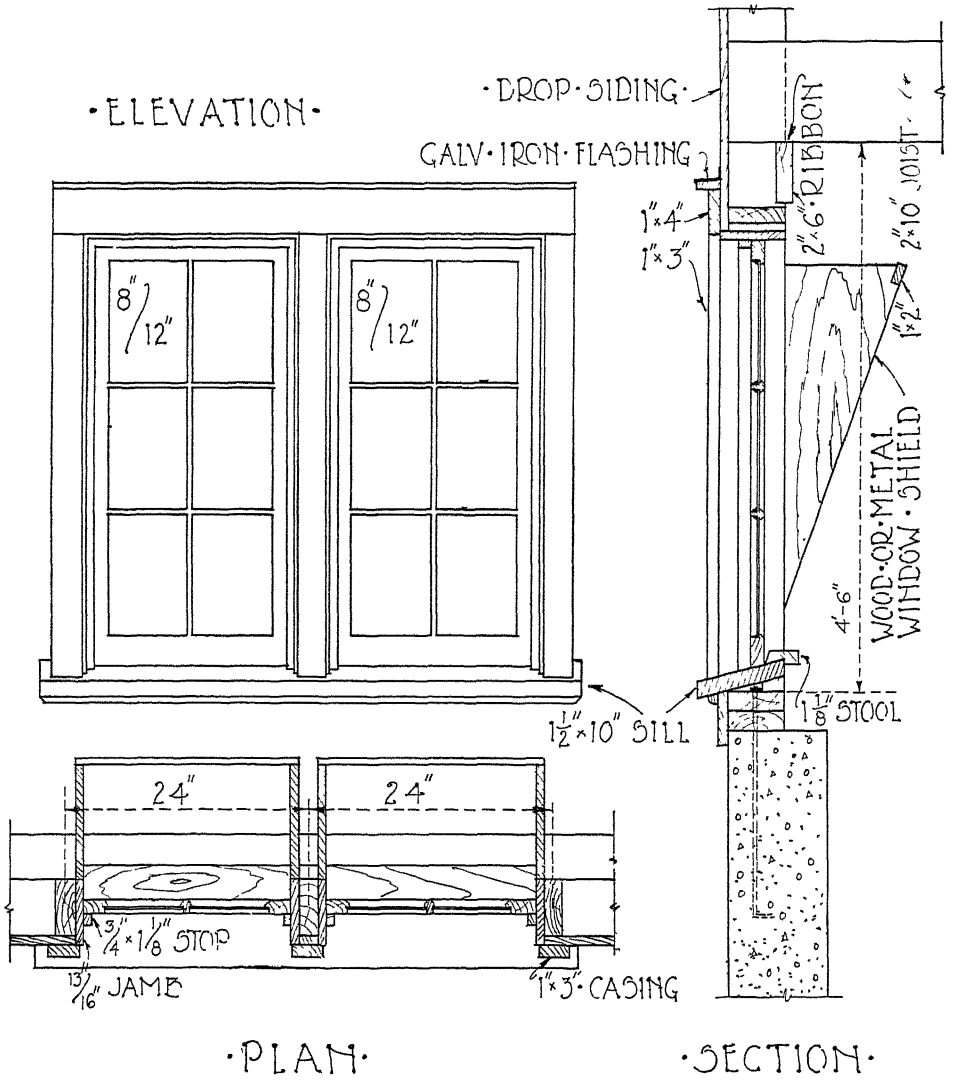

Fig. 12.—Window details. This type of window fits in between studs so that no strength is lost by cutting them. Each sash has 4 square feet of glass area in it, so that it supplies the light requirements for one dairy cow. See Fig. 17 for dormer window details

weakened at any one point. This continuous type is stronger than one composed of a single piece, broken at each column.

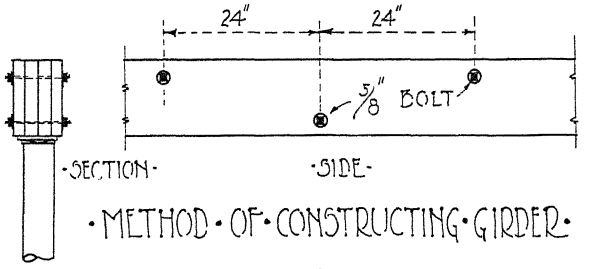

Fig. 13

JOISTS.—The 2- by 10-inch joists running crosswise of the barn, not only support the hay load above, but also tie the barn together. They are spaced 24 inches apart on center. The joists are lapped and spiked together over the girders; 1- by 3-inch bridging is placed midway of their spans.

WINDOWS AND DOORS. — Windows and doors in this type of barn can easily be placed at desired locations. Usually a 6-light, 8- by 12-inch sash is used in the window. This size sash has 4 square feet of glass area in it, so that one window will provide the necessary glass area for one dairy cow. The frame for this sash fits in between studs as shown in detail, Fig. 12. Dormer windows (Fig. 17) placed at intervals along the roof add greatly to the appearance of the barn and provide light and fresh air when mowing away hay.

The dimensions of the doors vary, according to their use. Doorways thru which stock must pass should be at least 3 feet 6 inches wide, while driveway doors must be 9 feet wide to allow passage of wagon or spreader. The height of

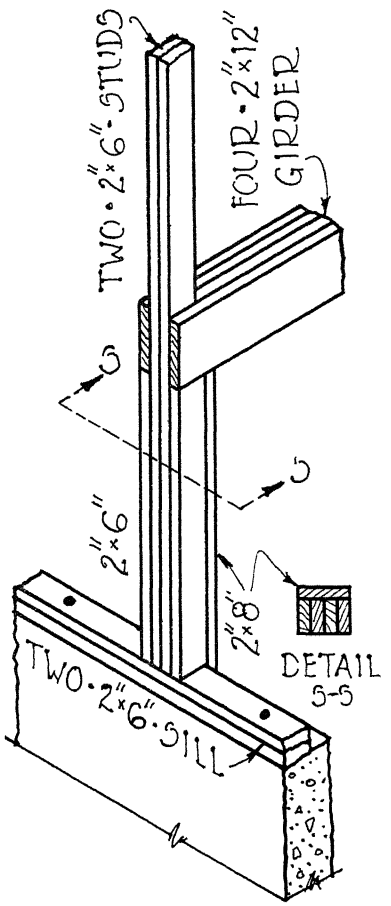

Fig. 14.—View showing construction at end of girders (also see Figs. 11 and 13). This illustration also shows details of sill and studding connections

these doors should be 8 feet. Hay doors openings are made 10 to 12 feet wide and about 13 feet high. Grain bin doors are usually 4 by 4 feet.

FLOOR PLANS.—While it is not the purpose of this bulletin to discuss the requirements and arrangements of the various types of barns yet two suggestive floor plans are shown in Figs. 20 and 21. These plans show arrangements that work in well with the braced rafter type of framing. Upon examining either of these plans it will be noticed that the feed room is centrally located for convenience in reaching all stock. The silo located at the side of the barn leaves the ends clear for future extensions, and makes it possible to take hay in from either or both ends of the barn.

Framing the Barn

In constructing a barn the sills, posts, girders, studs, plates, ribbons, joists, and sidewall braces are placed in their position and the floor laid, the necessary openings being left for various braces. Then the roof trusses are laid out on the mow floor. Usually the cross section is actually drawn to full scale on the mow floor by the use of chalked lines. When the section is completely drawn a set of rafters, braces, and a collar beam is carefully laid out over the chalked lines and their exact lengths and cuts determined. These are used as patterns and the rest of the pieces are cut from them. When all necessary pieces are cut, the two upper rafters, two lower rafters, two upper rafter braces, and the collar beam of the pattern pieces are again laid out over the chalked section on floor and spiked together to form the truss. Wall and rafter ties are constructed as shown in detail, Figs. 5 and 6. The lower rafter braces are not put in place until

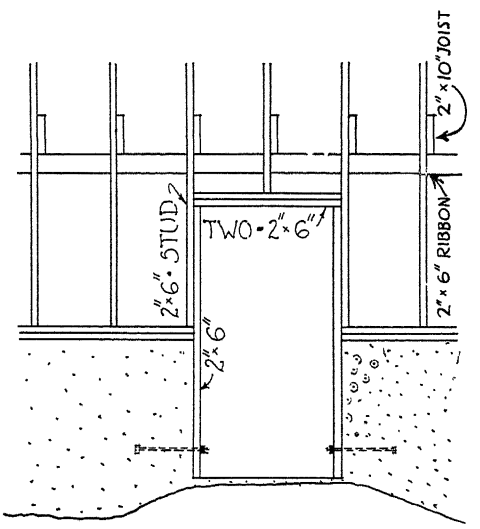

Fig. 15.—Framing around doors

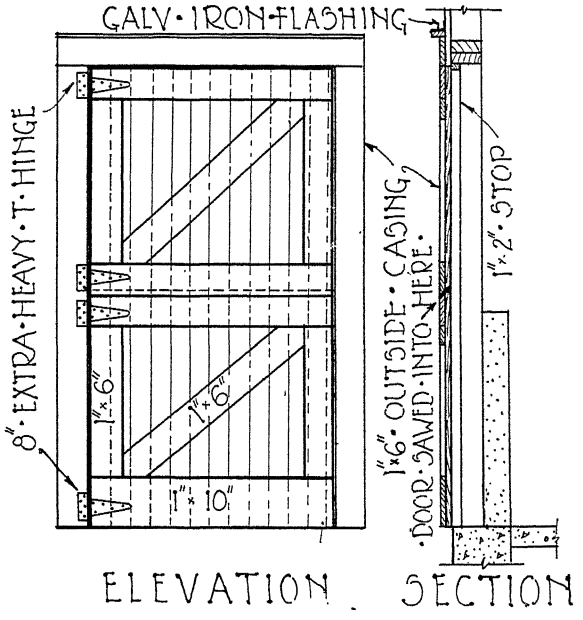

Fig. 16.—Door details. Door to be made in one piece, hung, and then sawed across the middle, so that it hangs in two sections. Top can be opened for ventilation. This type of door suitable for openings 4 feet or less in width. For wider openings use sliding door.

after the truss is raised. The remainder of the trusses are constructed on top of this one truss so as to insure uniformity. The end truss is hoisted up, plumbed, well spiked, and well braced. The remainder of the trusses are then raised to their position, being correctly spaced, plumbed, spiked, and braced in their position. There are several ways of raising the trusses. Figs. 1, 7, and 8 show the use of the gin pole to which is

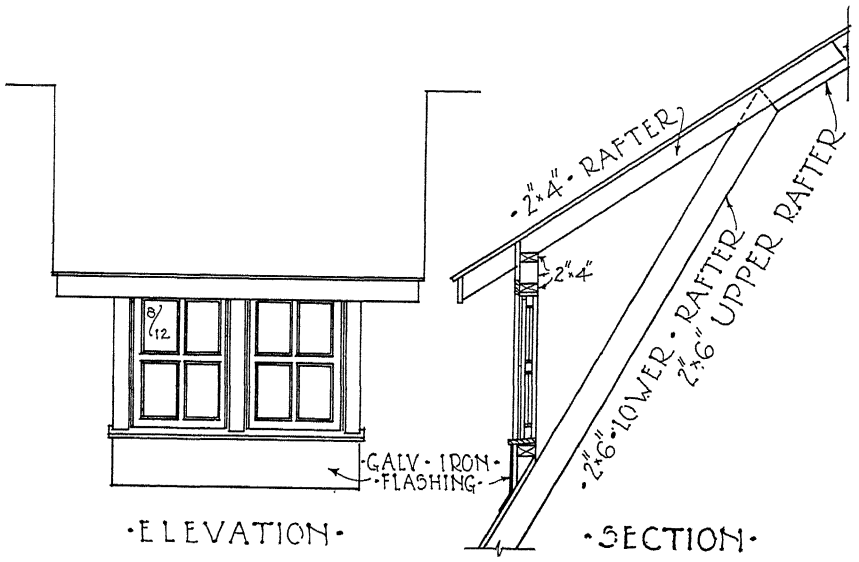

Fig. 17.—Details of dormer windows

fastened a block and tackle for lifting the trusses. The gin pole is held in place by means of guy ropes. Four men are required to raise the trusses by this method.

Another method is to build a temporary platform on rollers, which can be pushed along as the trusses are placed in position. The trusses are first raised from the floor to the platform and then with the ends of the lower rafters in position on the plate are raised up by hand. Sometimes a block and tackle is fastened to the collar beam and they are raised up by it.

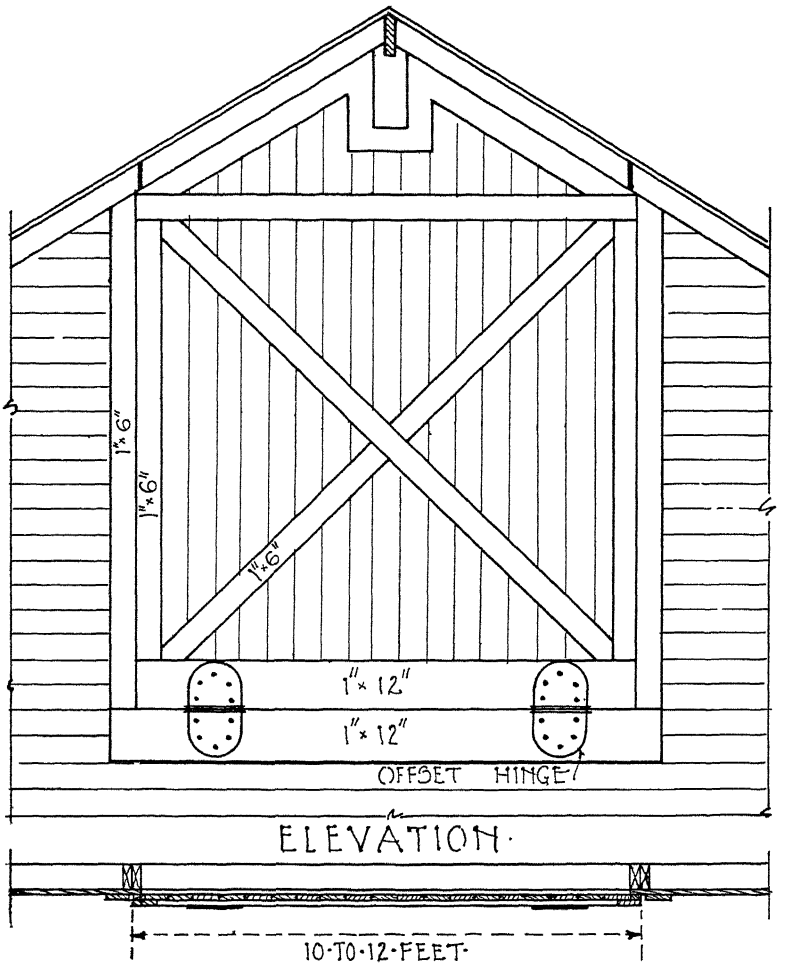

Fig. 18.—Details of hay door Door can be lowered and raised by hay carrier from the ground either by hand or with a horse

Still another way of using the platform is to assemble the trusses in halves. Each half, consisting of a lower rafter, upper rafter, and upper rafter brace tied together by a rafter tie, is then raised to its position and the collar beam and lower rafter brace are nailed on from the platform. This method requires the use of a 2- by 8-inch ridge pole.

Fig. 19.—It pays to bolt the sills to the foundation. A tornado could not lift this barn off its foundation, yet it slid the entire barn and foundation 4 inches toward the reader

An outstanding advantage of the braced rafter barn is that it requires so few men to construct and erect it. Instances have been known where barns have been built without experienced carpenter help. Mr. Frederick Lang of Wheelersburg, Ohio, built a braced rafter barn 32 by 60 feet in 15 days, employing only five men, who were not carpenters and had had no experience with braced rafter barn construction.

General Notes

All framing lumber should be yellow pine or good native lumber.

Sills should be bolted to the foundation with 5/8- by 20-inch bolts at intervals of from 6 to 8 feet.

The sills and all parts of the frame coming in contact with concrete, masonry or metal should be creosoted. Apply two paint coats of a creosote oil with a wire bound brush. The oil should be carefully brushed into all joints, checks, and depressions.

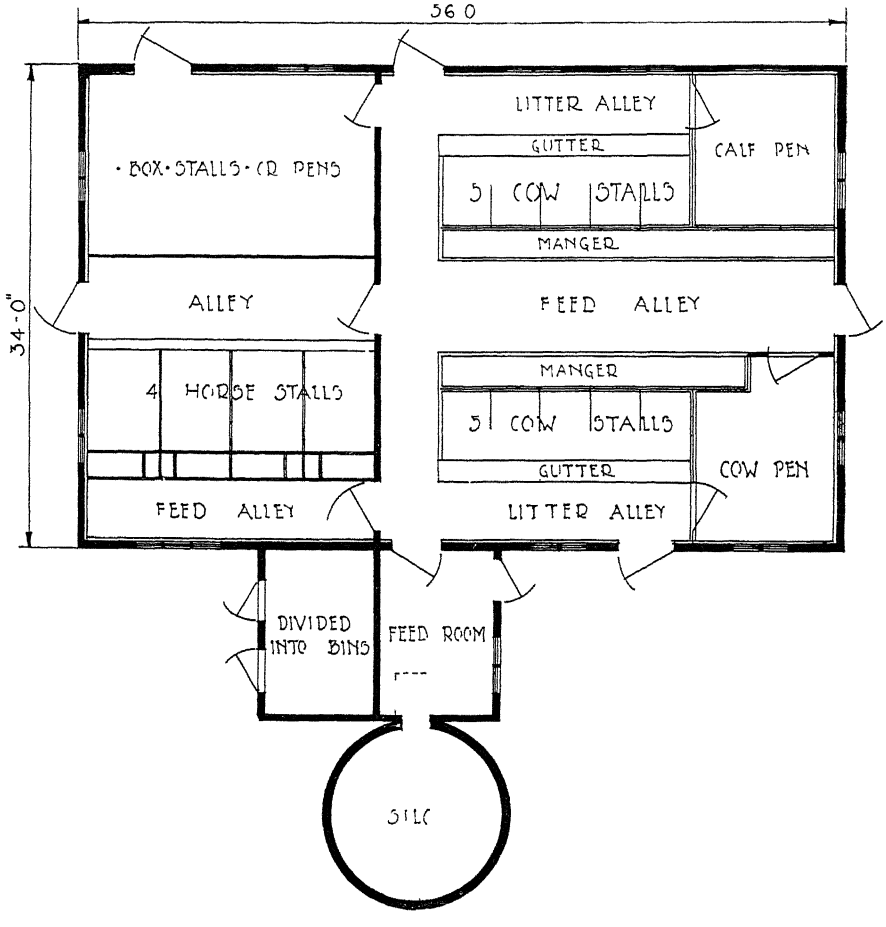

Fig. 20.—A general purpose barn. This barn can be lengthened at one or both ends to accommodate any number of animals. If it is desirable to arrange the horse stalls in two rows similar to the cow stall layout, the width of the barn must be increased to 36 feet

The siding should be 1- by 6-inch or 1- by 8-inch dropsiding laid horizontally.

Roof sheathing may be 1- by 4-inch boards spaced 2 inches apart for a metal roof. For prepared roofing the sheathing is laid solid, using any desired width of board. Laying the sheathing diagonally increases the strength and stiffness of the frame.

The loft floor should be made of dressed and matched lumber, 1- by 3-inch yellow pine flooring being preferred. A tight floor is necessary to prevent dirt and chaff from sifting thru into the stable.

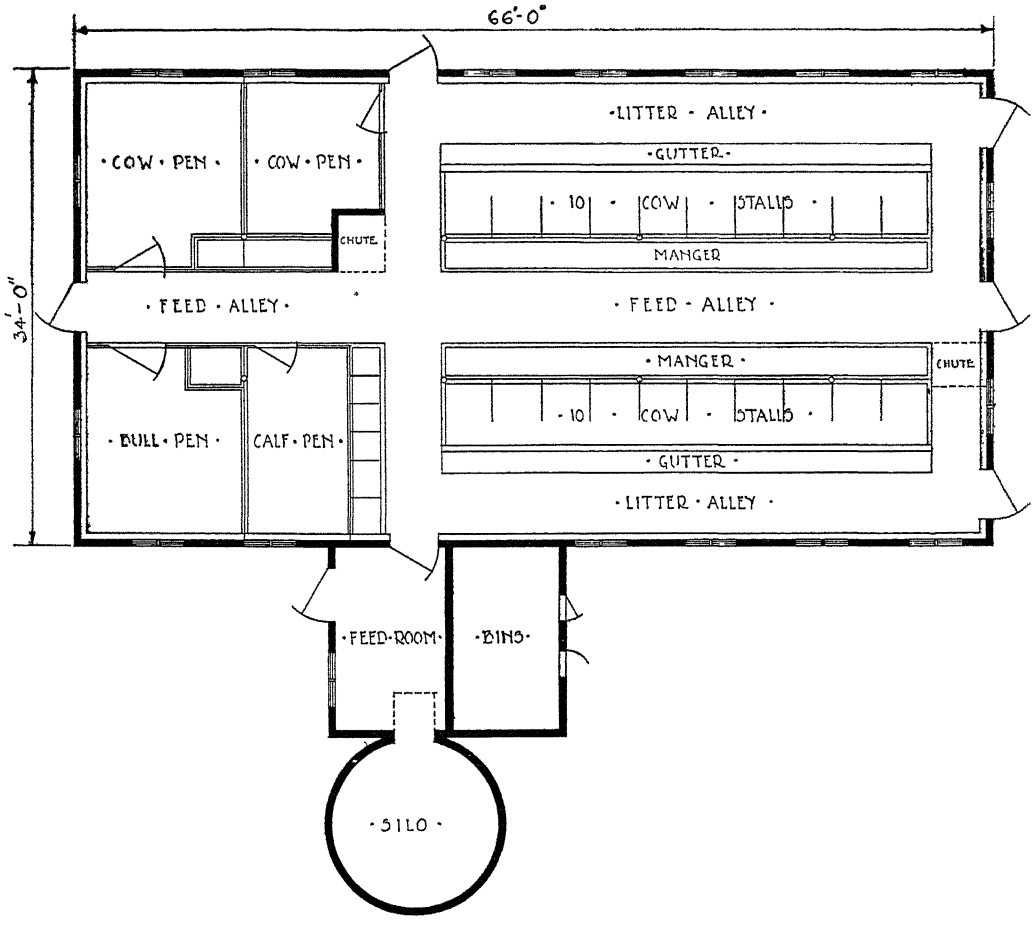

Fig. 21.—A standard dairy barn. A larger number of cow stanchions or pens can be provided by lengthening the barn. This arrangement is recommended by the American Society of Agricultural Engineers

Summary

The braced rafter type of barn construction is recommended for barns not exceeding 36 feet in width, 18 feet in height from grade line to plate, and not having threshing floors. The 34-foot width is particularly suitable for dairy barns.

This type of barn framing requires less lumber, is stronger and more rigid than the timber frame construction. It uses only stock sizes and lengths of lumber, takes only a few men to construct and erect the frame, and has a large, unobstructed mow.

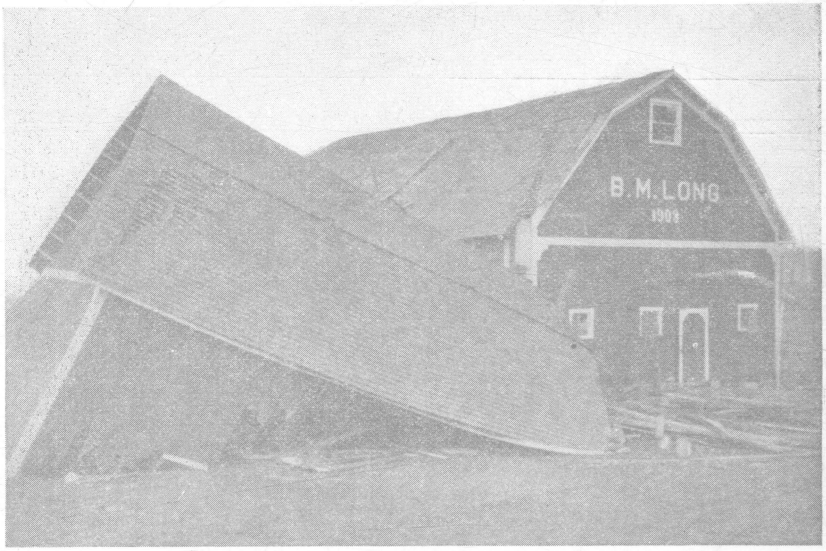

Fig. 22.—Results of a tornado. Which barn was bolted to the foundations?

Floor Plans

Local conditions and requirements make it impossible to design floor plans suitable for all farms. It is suggested that any farmer desiring to erect a modern dairy or general purpose barn, and finding the plans presented in this bulletin not suited to his purpose, should get in communication with his county agricultural agent, who can arrange to have complete floor plans drawn up by the Department of Agricultural Engineering of the Ohio State University.